HARRIS

Relation of Specific Gravity of the Blood to the Corpuscular Elements

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The Relation of the Specific Gravity of the Blood to the Corpuscular Elements

. BY .

CHESTER ELLIS HARRIS

THESIS

FOR THE

DEGREE OF BACHELOR OF ARTS

IN THE

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1902

S. A. F.

UNIVERSITY OF ILLINOIS

May 30 1902

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Chester Ellis Harris

ENTITLED The Relation of the Specific Gravity of the Blood to the Corpuscular Elements

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Arts

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HEAD OF DEPARTMENT OF Physiology

In some researches, recently carried on in this laboratory, on the regeneration of red corpuscles and blood-plates, made by bleeding dogs and watching the formation of these elements of the blood, variations were found in the counts made from day to day, for which there was no apparent explanation. It was thought that these variations could be shown to be due to a varying percentage of water in the blood, and accordingly the specific gravity was also taken in subsequent observations. It soon became apparent that the relation of the specific gravity to the number of red corpuscles, was not a simple one, and it was for the purpose of determining what relation, if any, existed between them that a more careful study of the specific gravity of the blood, was undertaken.

In our observations we made use of a method, which, so far as we know, has not been used before. This method consisted in making a count of the red corpuscles, a determination of the haemoglobin, and an estimation of the specific gravity, (and, in some cases a count of the white corpuscles also), from the same drop of blood. We were able to do this, by having three or four practised observers all working together. One person attended

The haemoglobin was determined by Fleischl's haemometer.

were using this solution in another part of our work where it was necessary to have a fluid which [illegible] would prevent blood corpuscles from [illegible]. Reference will be made to this later. We tried this solution and found that it preserved the corpuscles excellently both in form and in color.

[illegible] tions were taken to secure accuracy. In all cases we counted [illegible] the [illegible] ing in each [illegible] glass-[illegible] Thoma [illegible] instrument we used blood drawn from the [illegible] of blood, we used [illegible] The [illegible] were the numbers we got:

Hemocytometer A.	4'900'000.
[illegible]	[illegible]
[illegible]	4'600'000.

[illegible]

Table I.

No.	Count by A.	Count by B.	Difference.
1	[illegible]	8,000,000.	+ 300,000.
2	6,475,000.	6,700,000.	+ 225,000.
3	8,200,000.	[illegible]50,000.	- 350,000.
4	8,325,000.	8,300,000.	[illegible]
5	5,450,000.	5,700,000	+ 250,000.
6	7,750,000.	7,900,000.	+ 150,000.
7	6,150,000.	5,700,000.	- 450,000.
8	[illegible]	[illegible]	[illegible]50,000.

Each of these counts was made from a field of sixteen small squares.

However [illegible] counting, [illegible] from a pipette prepared by himself but from the same blood. We give here his experiments and the conclusions he draws from them.

Case I.

a. Each working independently

Sadler	4'143'500.
[illegible]	3'100'000.
Difference	1'043'500.

5. Pistil and stamens were exchanged.

Sadler	4'162'000.
Daland	3'525'000.
Difference	337'000.

Series I.

a

Sadler	[illegible]
Daland, same field	4'687'500.
Difference	000'000.

b [illegible]

Daland	4'000'000.
Sadler	4'150'000.
Difference	150'000.

Series II.

a [illegible]

Sadler two preparations	4'713'500.
	[illegible]
Difference	187'500.
Daland control one preparations from the same mixture	4'462'500.
[illegible]	4'818'750.
Difference	356'250.

b [illegible]

Daland two preparations	3'700'000.
	3'175'000.
Difference	525'000.

. Sadler counted one preparation

Haland's mean count. 3'431'500.

Mean of all Sadler's counts 4'128'725.

Difference 1'381'250.

Case I.

a. Sadler 6'225'000.

b. Sadler another preparation 6'162'000.

Haland another preparation 5'612'000.

c. Haland counted 64 squares. 5'925'000.

Sadler counted 64 squares. 5'750'000.

Difference. 175'000.

Case II

a. Sadler 6'212'000

5'850'000.

	Daland two preparations	[illegible]
	Difference	62'500.
C	Sadler 64 squares	5'926'000.
	Daland 64 squares	5'975'000.
	Difference	50'000.
	Case B.	
	Daland one preparation	[illegible]
	Sadler one preparation	3'687'500.
	Difference	313'500.
	Case C.	
	Sadler	[illegible]
	Daland	4'312'500.
	Difference	862'500.
	Case D.	
	Sadler	[illegible]
	Daland	[illegible]
	Difference	887'500.

"[illegible]

number with two thousand as to be counted, as
otherwise in case

thousand.

one pipette, one immediately after the oth-

eighty-seven-thousand, five hundred, to

three. If two observers take blood from the

Table II

		Roland	Difference
3.	4'143'000. 4'162'000.	3'100'000. 3'525'000.	1'043'000. 337'000.
4.	4'637'500.	4'000'000.	687'000.
5.		3'437'500.	1'381'250.
1.	6'225'000. 6'162'500.		550'000.
2.	6'212'000.	5'537'500.	674'500.
6.		4'000'000.	313'500.
7.	5'175'000.	4'312'500.	862'500.
8.	4'950'000	4'162'500	

than is

and

the number of

The causes

count than Roland. It was shown

that

times as fast as the

among

to the use of the

by

Determinations in the Hæmatocrit.

The hæmatocrit, which was first used by Hedon,[1] and afterwards strongly advocated by Daland[2] and by Lambert Gadesch's laboratory, is coming more and more generally into use as an instrument for the determination of the [illegible] number of determinations have to be made in quick succession, it is indispensable, since the hæmocy[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

hæmatocrit," which at first was turned by hand,

[illegible] number of revolutions per minute in each case, was about ten-thousand.

[illegible]

1. It must prevent absolutely the clotting of the blood.
2. It must not change the form of the corpuscles.
[illegible]
and they must not be moved by compensations.
4. It must give a constant volume in the least possible time.
5. [illegible]
6. [illegible]
7. It must have no destructive [illegible] on the blood-corpuscles.
8. It must [illegible] composed.

After experimenting with sodium chloride, sodium [illegible]

mixing was done on a watch-glass. The hematocrit tubes were filled by allowing a piece of rubber tubing and applying suction with the mouth, after which they were [illegible] minutes. At the end of this time the blood column had become stationary, and was sharply

Because [illegible] dichromate solution are mixed in the ampulla of the pipette, [illegible] the amount comes out eight to ten per cent low, due to the amount of blood which sticks to the walls of the pipette, and does not mix with the dichromate solution.

[illegible] would be detected, since we always centrifugate two hours [illegible] and [illegible] number X.

[illegible] the number of [illegible] and [illegible] number III. [illegible] method.)

Table

No.	Micrometer	Numerical	Difference
1.	3'837'625.	3'000'000	207'625
2.	4'279'000.	4'400'000	121'000
3.	4'128'125.	4'100'000	28'125
4.	5'058'333.	4'900'000	158'333
5.	[illegible]	[illegible]	[illegible]
6.	3'843'750.	3'600'000.	243'750.
7.	[illegible]	[illegible]	[illegible]
8.	4'606'250	4'600'000.	6'250

The table shows a comparison of the micrometer and the numerical values. In the first and fifth experiments the difference is very small. In these experiments the drop for the micrometer was measured with a pipette, and it was therefore impossible to get the whole drop into the pipette, and it was therefore impossible to get the whole drop into the pipette and was not mixed. On this account the reading could not be found as exactly as in the other experiments. If this ought to have been added to the results obtained by the micrometer the difference between the two methods would be only one hundred thousand, which is within the limits of error of the instrument. In the other experiments, which is shown in the table, in the experiments,

the blood was mixed in the ampulla of the white-cor
puscle [illegible] and in the other, the
[illegible] eight hundred [illegible]
[illegible] the hæmatocrit, the [illegible]
[illegible] hundred thirty, to [illegible]
[illegible] three thousand, seven hundred fifty. In
number two, three and eight tenths, the
hæmatocrit count was [illegible] five
hundred twenty-seven, [illegible]
seventy three; in numbers two and seven, the
mean was eighty-eight thousand, eight hundred
seventy [illegible] greater than [illegible] of the
cytometer. In the [illegible] a mean of only
two thousand, five hundred sixty two,— a very
small variation.

In two experiments [illegible] the hæmato
crit count was, in one instance, two hundred
seventy thousand, eight hundred [illegible]
cytometer, and in the other, one hundred
twenty thousand lower. Taking these
varying cases, we find that the hæmatocrit
count has an average of one hundred fifty thou-
sand higher than the hæmocytometer.

		Haemocytom	with Haematocrit	Haemocytom/Haemoglobin	Haemocytom to Hb. p.
1.	52.5	3'150'000	3'000'000	150'000	59'660.
3	50.	5'950'000	4'000'000	1'950'000	74'377.
4.		5'775'000	4'400'000.	1'375'000	——
5.		5'975'000	5'400'000.	575'000	70'294
6.		5'463'000	4'800'000	663'000	——
7.					
8.		600'260	1'200'000.	599'740	60'026
9.		562'500	800'000.	237'500	56'250
10.					
11		5'437'500.	4'400'000	1'137'500	67'968
12.		5'375'000.	3'200'000	2'175'000	——
13					
14		4'412'000.	3'600'000	812'000	80'218
15		4'180'000.	3'000'000	1'180'000	76'000
16.	—	3'181'808.	2'500'000	981'808	——
17	—	3'593'750.	2'400'000.	1'193'750	——
18.	—	2'230'000	2'000'000	230'000	——
19.					
20.					
21.					
22.		3'637'500.	2'800'000	1'837'500	80'833
23.		2'062'800	1'700'000	1'700'000	68'760

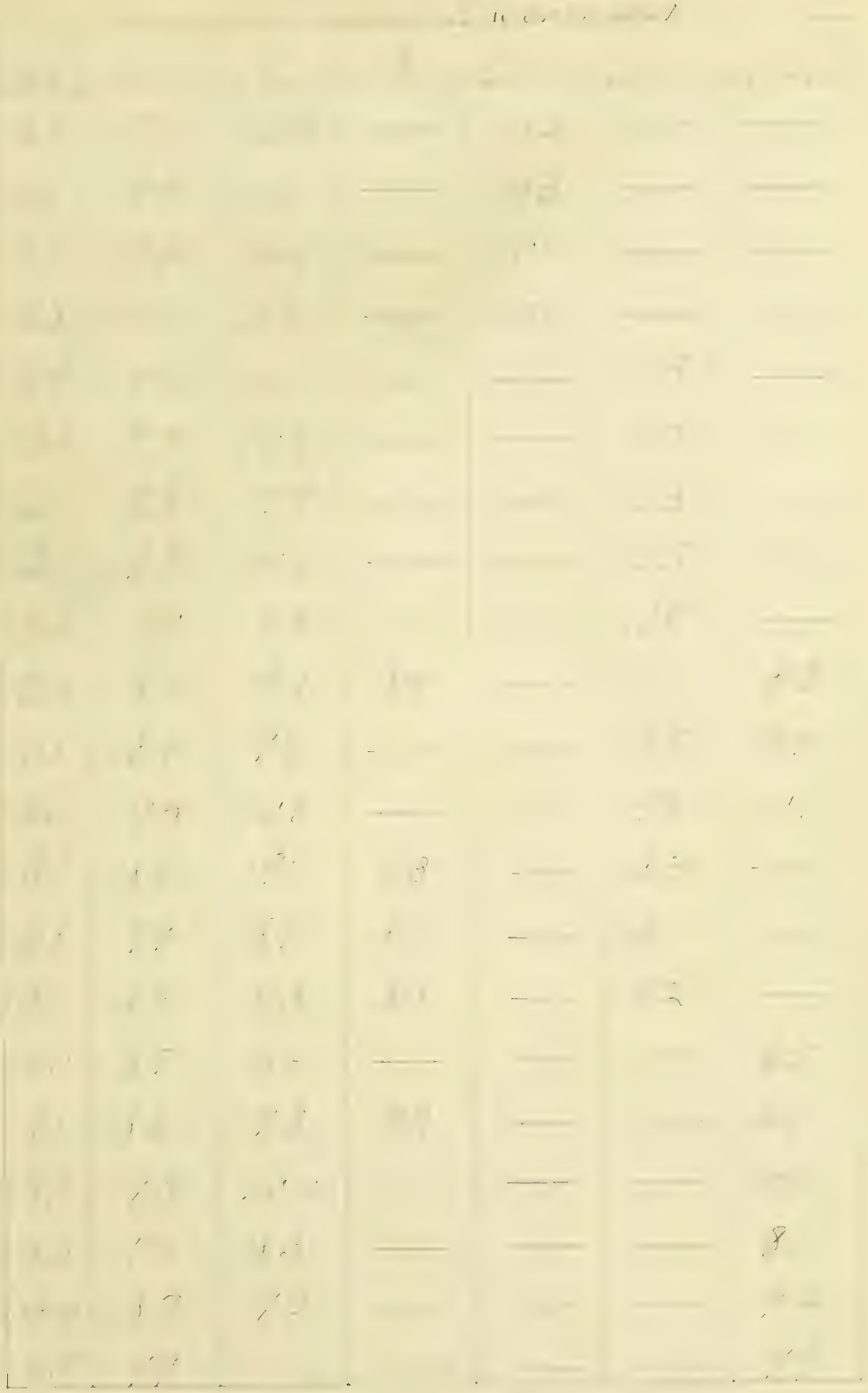
Table LL

		2'160'000	1'650'000	1'210'000	
	30	2'187'500	1'600'000		92'500
			4'200'000	1'762'500	
			3'300'000	1'110'000	
		5'960'000	3'600'000	2360'000	132'444
				1'637'000	
		3'025'000	2'000'000	1'025'000	75'625
		2'900'000	2'400'000	500'000	72'500
		3'160'000	2'500'000	660'000	79'000
		3'575'000	2'200'000	1'375'000	
				170'769	
		4'830'000			
		4'830'000	4'200'000	630'000	
		5'864'000	4'800'000		
		5'037'500	5'000'000	375'000	
		5'387'500			
		3'974500		974'500	61'146
		3'200'000	2'700'000	500'000	91'428
		4'637'500		837'500	
				137'500	
		6'912'000			

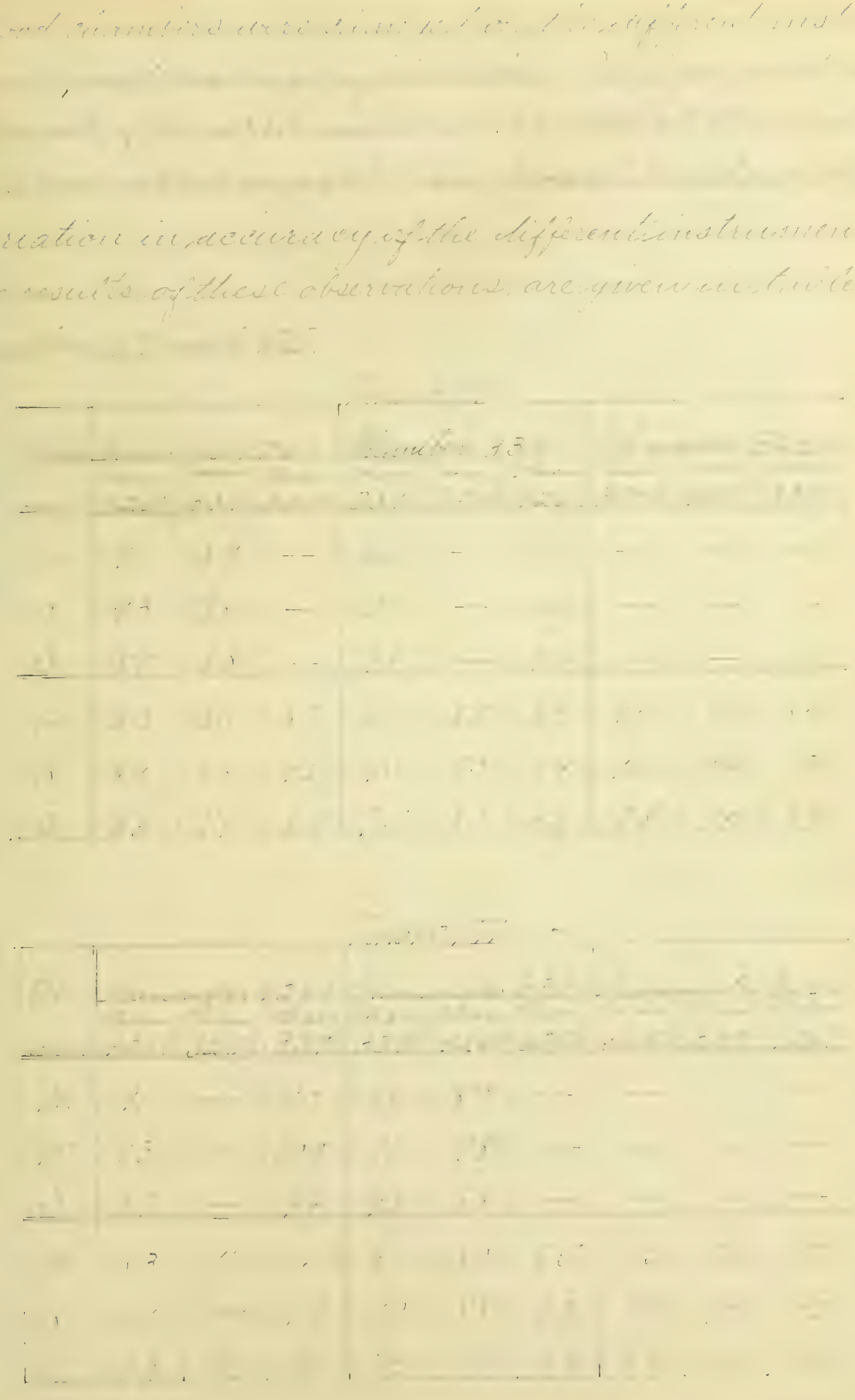
[illegible]

[illegible] three readings were taken with the same col-
[illegible], and the average of these was recorded.

[illegible]tion in individual readers in matching the col-
[illegible]s, is considerable. We happened to be in a posi-
[illegible] to test this variation for six individuals, all



with each hammer, the



gravity of the blood, and he has also studied the specific gravity of the blood in various diseases. The results of his observations on anaemic blood are given in table VIII, and are of value for comparison with our own observations on normal blood given in table

His researches are the fullest we have been able to find in the literature of the subject. [illegible]

[illegible]

(1) [illegible]

[illegible]

[illegible][5] [illegible]

[illegible][6] [illegible] to 1071.

	3'364'000
	2'972'000
	2'728'000
	4'400'000
	2'448'000
	3'352'000
	—
	3'360'000
	3'380'000
	3'604'000
	3'440'000
	———
	———
	3'376'000
	———
	———
	———

Table III (continued)

		Number of red corpuscles	Ratio of the number of red corpuscles to the colors to the
		3'096'000	
		—	
		4'068'000	
		3'536'000	
		—	
		—	
		—	
		464'000	

		number of red corpuscles	Ratio of Volume of Red Corpuscles to Vol.
		7'108'000	
		4'664'000	
		352'000	

Table 1

Specific gravity	Density gradient
1.030 - 1.035	25 - 30 cm
1.035 - 1.040	
1.040 - 1.045	
1.045 - 1.048	
1.050 - 1.053	
1.053 - 1.055	

the fact that the specific gravity does not

the estimated variations in specific gravity,
by varying the pressure on the surface from which
the blood was drawn. It is well known that

, will yield varying
numbers of red corpuscles

15

having the point of the
es, in order to detach

is added to the mixture until the

		1063	1014.7	6'300'000
		1063	1014.7	6'100'000
		1060	1027.8	5'260'000
		1062.9	1027.8	5'775'000
	9:00	1058.9	1027.5	4'900'000
	9:20	1063.2	1027.5	5'100'000
	9:40	1058.9	1027.5	5'350'000
	8:30	1062.2	1008.3	5'200'000
	8:50	1060.7	1008.3	5'000'000
	9:20	1059.7	1008.3	5'150'000
				5'350'000
				5'450'000
				5'300'000
				5'550'000
				5'450'000
				5'000'000
	10:30	1063.	1014	5'150'000
		1060	1013.5	5'550'000
	:40	1060.2	1013.5	5'450'000

Date	Time	Spec Grav of the Blood	Spec Grav of the Urine	Quantity of Urine passed
		1061.2	013.2	5'000'000
		1061.2	1013.2	
		1062.8	013.2	5'600'000
				5'400'000
		1064.4	1015.6	5'450'000
	35	1063.3	1028	5'250'000
	0	1062.1	1028	5'400'000
		1070	1028	5'600'000
		1060.2	1016	
		1060.2	1016	5'250'000
		1064.9	1016	
		1061.8	1019.3	
		1060.7	1019.3	6'150'000
		1065.4	1019.3	5'400'000
	11:30	1061.9	1019.3	5'600'000
				5'000'000
				5'275'000
				5'400'000

			4'300'000
			5'450'000
			5'200'000
			4'600'000
			5'500'000
			5'500'000
			5'300'000
			5'550'000
			5'400'000

2.				
5.				

Where the pressure is slight, the specific gravity is greater than [illegible] and the weight of the [illegible] without pressure, but the moisture is [illegible]

[illegible] the specific gravity [illegible] pressure was used, the increase was [illegible]

these factors can be between as numerical under for either of the other two.

strong pressure diminished the a-

Insert

3'860'000.

, 1893; Zeitschr. für klin. Med., xxii. pp. 475, 1892.

2. Quincke, Fortschritte der Medicin, 1891, Vol. IX, pp. 823–833, and 867–879.

3. Hayem, du Sang, 1889, p. 400.

4. Schmaltz, Deutches Archiv. für klin. Med. 1890, Vol. 47, p. 152.

5. Oertel, Therap. Monatsheft, ii, 6, 1888. (Quoted from Schmaltz, Deutsch. med. Woch., 1891, p. 558.

7. Schmaltz, Deutch. med. Woch., 1891, p. 558.

8. Krüger, Zeitsch. für Biol., 1890, Vol. 26, p. 4. (Quoted from Schmaltz

chen, Leipsic, 1891.

10. Cabot, A guide to the clinical examination of the blood, etc. Wm. Wood & Co., New York, 1897, p. 31.

terheilkunde, 1894, Vol. II, pp. 214–215.

from Hamel, p. 26.

p. 20.

14. Hedin, Skandinavisches Archiv. für Physiologie, 1891, Vol. 2, pp. 360-372.
15. Jones, British Medical Journal, 1888, Vol. 2, p. 1345.